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# Mathematics

## Quarter 2 – Module 1: Graphs of Polynomial Functions

**Mathematics – Grade 10**
**Alternative Delivery Mode**
**Quarter 2 – Module 1: Graphs of Polynomial Functions**
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# Mathematics

## Quarter 2 – Module 1:
## Graphs of Polynomial Functions

# Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

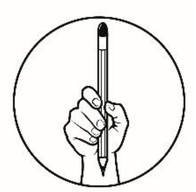
Thank you.

## What I Need to Know

This module was designed and written with you in mind. It is here to help you graph polynomial functions. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course but the order in which you read and answer this module is dependent on your ability.

After going through this module, you are expected to:

a. describe and interpret the graphs of polynomial functions; and
b. graph the polynomial functions



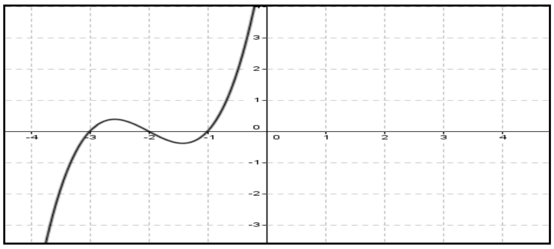
## What I Know

Choose the letter of the correct answer and write it on a separate sheet of paper.

1. Which of the following is a polynomial function?
   A. $y = x^{-3} + 2x^2 + x - 1$ C. $f(x) = \sqrt{2}x^3 + 5$
   B. $y = \frac{3}{x} - 2x^3 + 5x - 4$ D. $f(x) = x^{\frac{2}{3}} + 1$
2. Find the zeros of $P(x) = (x+4)^3(x-5)^6$.
   A. $\{-4\ multiplicity\ 3,\ 5\ multiplicity\ 6\}$
   B. $\{4\ multiplicity\ 6,\ -5\ multiplicity\ 3\}$
   C. $\{-4\ multiplicity\ 5,\ -5\ multiplicity\ 5\}$
   D. $\{4\ multiplicity\ 3,\ 5\ multiplicity\ 6\}$
3. What is the factored form of $f(x) = x^3 - 2x^2 - 3x$?
   A. $f(x) = (x-3)(x+1)$ C. $f(x) = x^2(x+3)(x-1)$
   B. $f(x) = x(x-3)(x+1)$ D. $f(x) = (x+3)(x-1)$
4. Determine the degree of $f(x) = (x+3)(x-4)^2(x+4)^3(x+1)^5$.
   A. 9 B. 10 C. 11 D. 12
5. Given that $P(x) = 2x^3 + 3x^2 - 4x - 24$, what is the value of $P(3)$?
   A. 42 B. 43 C. 44 D. 45
6. Which of the following is one of the factors of $P(x) = x^3 + x^2 - 6x - 6$ ?
   A. $x+1$ B. $x-1$ C. $x+5$ D. $x-5$
7. What is the leading coefficient of $P(x) = (2x+2)(5x-2)(x+3)$?

A. 10 B. $-1$ C. $-2$ D. $-21$

8. On the Cartesian plane, where is the turning point of the graph of $f(x) = x^4 + 1$ located?
   A. above the x-axis
   B. on the x-axis
   C. below the x-axis
   D. on the y-axis
9. What determines the end behavior of the polynomial function?
   A. vertical line test
   B. horizontal line test
   C. leading coefficients test
   D. multiplicity test
10. How do you describe the behavior of the graph if the degree is even and the leading coefficient is negative?
    A. The graph rises to the left and falls to the right.
    B. The graph falls to the left and rises to the right.
    C. The graph falls on both sides.
    D. The graph rises on both sides.
11. Describe the behavior of the graph of the function $P(x) = (x+1)(x-1)(x-3)$.
    A. The graph rises on the left and falls on the right.
    B. The graph falls on the left and rises on the right.
    C. The graph falls on both sides.
    D. The graph rises on both sides.
12. What are the x-intercepts of the graph of $y = (x-3)(x+1)\ (x-1)$?
    A. $3, 1, 1$ B. $-3, 1, 1$ C. $3, 1, -1$ D. $-3, -1, -1$
13. Determine the number of turning/s of the graph of $P(x) = (x-3)(x+1)\ (x-1)$?
    A. 4 B. 3 C. 2 D. 1
14. Which of the following best describes the graph of the polynomial function $y = x^3 - 4x^2 + 3x - 12$?
    A. Graph falls to the left and rises to the right.
    B. Graph rises to the left and falls to the right.
    C. Graph rises on both sides.
    D. Graph falls on both sides.
15. Which polynomial function in factored form is represented by the given graph?
    A. $P(x) = (x-3)(x-2)(x-1)$
    B. $P(x) = (x+3)(x+2)(x+1)$
    C. $P(x) = (x-3)(x+2)(x-1)$
    D. $P(x) = (x+3)(x-2)(x+1)$



# Graphs of a Polynomial Function

In the previous module, you learned about determining polynomial functions. Refresh your mind by answering the activity below.

## *What's In*

Direction: Classify each function as polynomial or not by completing the table below. If the function is a polynomial, identify the degree and the leading coefficient. Write your answer on a separate sheet of paper.

| | |
|---|---|
| $P(x) = x + x^2 + x^3$ | $P(x) = x^{\frac{1}{2}} + 2$ |
| $P(x) = x^4 - \frac{1}{8}x$ | $P(x) = 4x - 2 + 2x - 3$ |
| $P(x) = \frac{3}{x}$ | $P(x) = 12$ |
| $f(x) = 9\sqrt{x} + 2x$ | $P(x) = 5x + 1$ |
| $f(x) = x^{\frac{4}{2}}$ | $P(x) = x^3 + x^4 + x^6$ |
| $f(x) = 5 - \frac{4}{x^2}$ | $P(x) = 5 - x^{11}$ |

Questions:

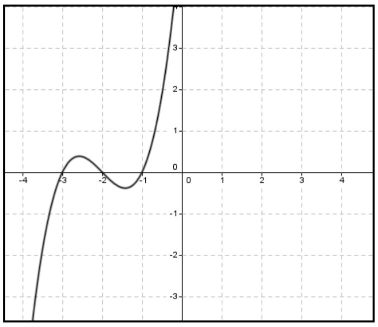
| Polynomial Function | | | Non-Polynomial Function |
|---|---|---|---|
| Polynomial Function | Degree | Leading Coefficient | |
| | | | |
| | | | |
| | | | |
| | | | |

1. Describe a polynomial function.

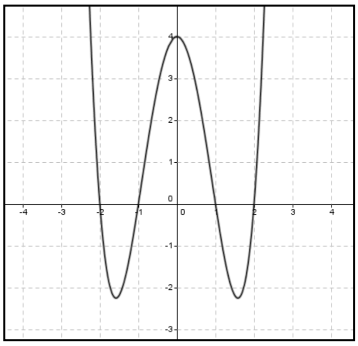
2. What are the characteristics of non-polynomial functions?

## *What's New*

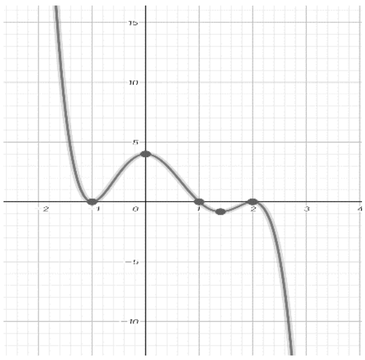
After recalling polynomial functions, you will now see polynomial functions and its corresponding graphs. Study the graph and the polynomial function of each figure and complete the table in the next page.



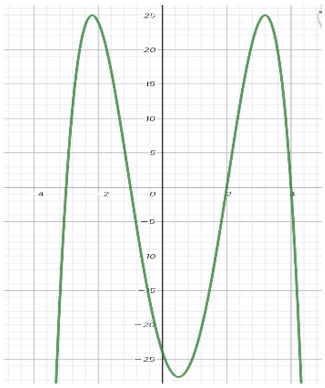
$P(x) = (x + 3)(x + 2)(x + 1)$



$P(x) = (x + 2)(x + 1)(x - 1)(x - 2)$



$P(x) = -(x + 1)^2(x - 1)(x - 2)^2$



$P(x) = -(x + 3)(x + 1)(x - 2)(x - 4)$

| Polynomial Function | Leading Coefficient (*$a_n$ > 0 or $a_n$ < 0*) | Degree *(Even or Odd)* | End-Behavior of the Graph | |
|---|---|---|---|---|
| | | | Left Tail *(rises or Falls)* | Right Tail *(rises or falls)* |
| 1. $P(x) = (x+3)(x+2)(x+1)$ | | | | |
| 2. $P(x) = (x+2)(x+1)(x-1)(x-2)$ | | | | |
| 3. $P(x) = -(x+1)^2\,(x-1)\,(x-2)^2$ | | | | |
| 4. $P(x) = -(x+3)(x+1)(x-2)(x-4)$ | | | | |

Did you correctly identify the leading coefficient, degree and the behavior of the graph? If yes, then congratulations! You should have recognized that this can help you determine the behavior of the graph of a polynomial function as x increases or decreases without bound.

## *What is It*

From the activity in the What's new, your answers should be:

1. For the polynomial function $P(x) = (x+3)(x+2)(x+1)$, the degree is 3 (odd), the leading coefficient is 1(positive) and the graph falls to the left and rises to the right.
2. For the polynomial function $P(x) = (x+2)(x+1)(x-1)(x-2)$, the degree is 4 (even), the leading coefficient is 1(positive) and the graph rises both to the left and right.
3. For the polynomial function $P(x) = -(x+1)^2\,(x-1)\,(x-2)^2$, the degree is 5 (odd), the leading coefficient is $-1$(negative) and the graph rises to the left and falls to the right.
4. For the polynomial function$P(x) = -(x+3)(x+1)(x-2)(x-4)$, the degree is 4 (even), the leading coefficient is $-1$(negative) and the graph falls both to the left and right.

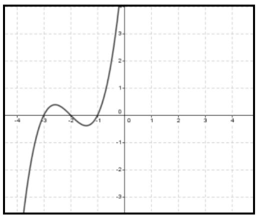
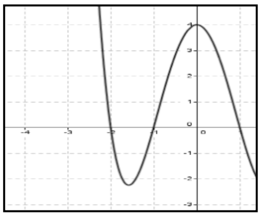
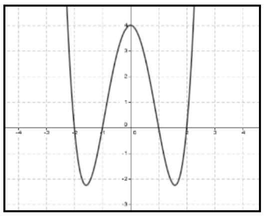
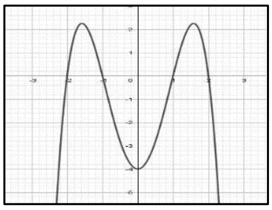
Noticed that the degree and the leading coefficient of the polynomial functions determine the end-behavior of the graph.

**There are four cases of the Leading Coefficient Test:**

Given a polynomial function in standard form,

$P(x) = a_n x^n + a_{n-1}x^{n-1} + a_{n-2}x^{n-2} + \ldots + a_1 x + a_0$

The table below shows the behavior of the graph of polynomial function in standard form.

| | Leading Coefficient | Degree | End-Behavior of the Graph |
|---|---|---|---|
| Case 1 | Positive | Odd | Falls left  rises right |
| Case 2 | Negative | Odd | Rises left  Falls right |
| Case 3 | Positive | Even | Rises left  Rises right |
| Case 4 | Negative | Even | Falls left  Falls right |

**Summary of the Leading Coefficient Test**

1. Case 1 showed that if the degree of the polynomial is odd and the leading coefficient is positive, then the graph falls to the left and rises to the right.
2. Case 2 showed that if the degree of the polynomial is odd and the leading coefficient is negative, then the graph rises to the left and falls to the right.
3. Case 3 showed that if the degree of the polynomial is even and the leading coefficient is positive, then the graph rises to the right and also rises to the left.
4. Case 4 showed that if the degree of the polynomial is even and the leading coefficient is negative, then the graph falls to the left and also falls to the right.

**Here are the steps involved in graphing polynomial functions:**

1. Write the function in factored form.
2. Determine the end-behavior of the graph of a given polynomial function using the Leading Coefficient Test.
3. Find the zeros of the polynomial function and their multiplicity.
   - If $(x-a)^k$ is a factor of the polynomial function, then $a$ is a zero of multiplicity $k$. The multiplicity refers to the exponent of the factors of the polynomial.
   - If the multiplicity of the zeros is even, then the graph touches the x-axis or tangent to the x-axis.
   - If the multiplicity of the zeros is odd, then the graph crosses the x-axis.
4. Construct a table of values for x and $P(x)$.
5. Plot the points and draw a smooth continuous curve to connect the points.
6. Make sure that the graph follows the end behavior as found in the above step.

**Example 1.** Describe the behavior of the graph by completing the table.

| Function | Factored Form | Degree | Leading Coefficient | End-behavior of the graph | |
|---|---|---|---|---|---|
| | | | | Left Tail | Right Tail |
| 1. $P(x) = x^3 - 2x^2 - 3x$ | | | | | |
| 2. $P(x) = -x^3 + x^2 - 12x$ | | | | | |

Solution:

1. Factor the given function using the factoring techniques you have learned:
   - $x^3 - 2x^2 - 3x \longrightarrow x(x^2 - 2x - 3) \longrightarrow x(x+1)(x-3)$
   - $-x^3 + x^2 - 12x \longrightarrow -x(x^2 - x + 12) \longrightarrow -x(x-4)(x+3)$
2. The degree of the polynomial function in one variable can be easily identified when it is written in standard form. The degree is the highest exponent of the function. In this case, the degree of $P(x) = x^3 - 2x^2 - 3x$ is 3 and the degree of $P(x) = -x^3 + x^2 - 12x$ is 3.
3. The leading coefficient is the numerical coefficient of the term with the highest degree. The leading coefficient of $P(x) = x^3 - 2x^2 - 3x$ is 1 and for $P(x) = -x^3 + x^2 - 12x$ is $-1$.

4. Using the Leading Coefficient Test, the graph of $P(x) = x^3 - 2x^2 - 3x$ is falling at the left and rising at the right while the graph of $P(x) = -x^3 + x^2 - 12x$ is rising at the left and falling at the right.

**Example 2.** Given the function in factored form, $P(x) = (x+2)^2(x+1)^3(x-1)^4(x-2)$. Complete the table below by finding the zeros, multiplicity of the zeros, characteristic of its multiplicity and behavior of the graph.

| Zeros | Multiplicity of Zero | Characteristic of the Multiplicity | Behavior of the Graph |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

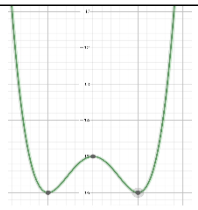
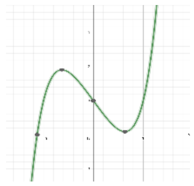
Solution:

- To find the zeros of $P(x)$ set $P(x) = 0$ and solve for the values of $x$. That is,
  $(x+2)^2 = 0$, $(x+1)^3 = 0$, $(x-1)^4 = 0$, $(x-2) = 0$

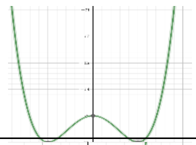
  The zeros are the x – intercepts of the polynomial function. It is where the graph crosses or touches the x – axis.
- The exponent of each factor is the multiplicity of the zero. Hence, the zeros $-2$ is of multiplicity 2, $-1$ is of multiplicity 3, 1 is of multiplicity 4, and 2 is of multiplicity 1.
- To determine the characteristic of the multiplicity, just indicate whether the exponent of the factor is even or odd.
- If the multiplicity of the zero is even, it means that the graph will just touch the x – axis at the zero while if odd it will cross the x – axis at the zero.

| Zeros | Multiplicity of Zero | Characteristic of the Multiplicity | Behavior of the Graph |
|---|---|---|---|
| $-2$ | 2 | Even | touches the x-axis at $-2$ |
| $-1$ | 3 | Odd | crosses the x-axis at $-1$ |
| 1 | 4 | Even | touches the x-axis at 1 |
| 2 | 1 | odd | crosses the x-axis at 2 |

**Example 3.** Complete the table below.

| Polynomial Function | Sketch | Degree | Number of Turning Points |
|---|---|---|---|
| 1. $P(x) = x^4 - 2x^2 - 15$ |  | | |
| 2. $P(x) = x^5 + x^3 - 2x + 1$ |  | | |

Solution:

| Polynomial Function | Sketch | Degree | Number of Turning Points |
|---|---|---|---|
| 1. $P(x) = x^4 - 2x^2 - 15$ |  | 4 | 3 |
| 2. $P(x) = x^5 + x^3 - 2x + 1$ |  | 5 | 2 |

Take note: Quartic functions like $P(x) = x^4 - 2x^2 - 15$ have odd number of turning points while quintic functions like $P(x) = x^5 + x^3 - 2x + 1$ has even number of turning points. The number of turning points is **at most** $(n - 1)$, where $n$ is the degree of the polynomial function.

**Example 4.** Make a table of values for x and P(x) of the polynomial function:

$$P(x) = (x - 1)^3(x + 2)^2$$

Solution: The zeros of the given polynomial are 1 and $-2$. These zeros divide the $x-$ axis in to three intervals: $(\infty, -2)$, $(-2, 1)$ and $(1, \infty)$. Hence, make a table of values by choosing an arbitrary $x-$ value from each interval so that you can see the behavior of the graph from each interval. Include the zeros of the polynomial function in your table of values.

| x | $-3$ | $-2$ | $-1$ | 0 | 1 | 2 |
|---|---|---|---|---|---|---|
| P(x) | | | | | | |

Substitute the selected values of $x$ to the given polynomial function. Then simplify.

If $x = -3$    $P(-3) = (-3 - 1)^3 ( -3 + 2)^2$
$P(-3) = (-4)^3 (-1)^2 = (-64) (1) = -64$

If $x = -2$    $P(-2) = (-2 - 1)^3 ( -2 + 2)^2$

$P(-2) = (-3)^3 ( 0 )^2 = 0$

If $x = -1$    $P(-1) = (-1 - 1)^3 ( -1 + 2)^2$

$P(-1) = (-2)^3 ( 1 )^2 = -8$

If $x = 0$    $P(0) = (0 - 1)^3 ( 0 + 2)^2$

$P(0) = (-1)^3 ( 2 )^2 = - 4$

If $x = 1$    $P(1) = (1 - 1)^3 ( 1 + 2)^2$

$P(1) = (0)^3 ( 3 )^2 = 0$

If $x = 2$    $P(2) = (2 - 1)^3 ( 2 + 2)^2$

$P(2) = (1)^3 ( 4 )^2 = 16$

| x | −3 | −2 | −1 | 0 | 1 | 2 |
|---|---|---|---|---|---|---|
| P(x) | −64 | 0 | −8 | −4 | 0 | 16 |

**Example 5.** Sketch the graph of the polynomial function

$$P(x) = x(x - 3)(x + 1).$$

Solution: Let us use the steps in graphing the polynomial function

Step 1. Factor the polynomial function. The given function is already in factored form.

Step 2. The x – intercepts are -1, 0 and 3. Plot these values to create intervals.

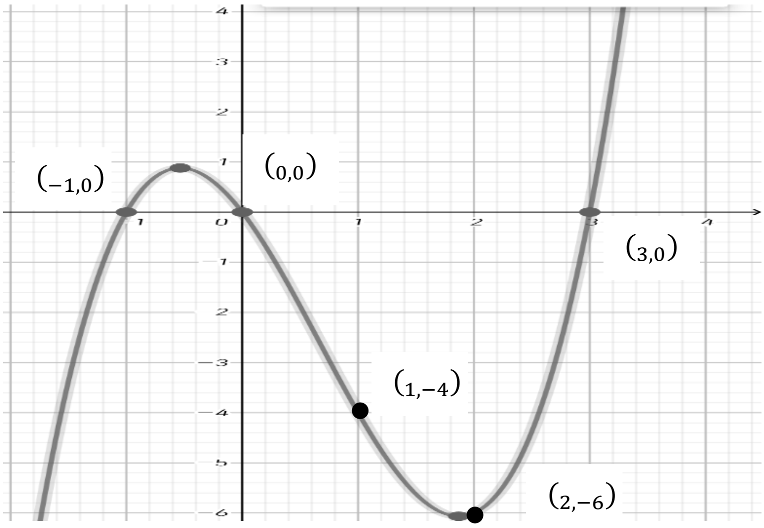
Step 3. The degree is 3 which is odd and the leading coefficient is positive 1. Thus, the graph falls on the left and rises on the right.

Step 4. Fill in the table of values for P(x) by using x – values in each Interval

| x | −2 | −1 | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| P(x) | −10 | 0 | 0 | −4 | −6 | 0 |

Step 5. Plot all the points and connect the points with a smooth curve.

Step 6. The number of turning points is 2.




With the technology readily available at your fingertips, you can use downloadable apps in graphing like Desmos and Geogebra. These will help you in graphing polynomial functions easily and efficiently.

## *What's More*

To enhance more of your skills in graphing polynomial function, perform the next activities.

**Assessment 1**

Direction: Complete the table below by identifying the factored form, leading coefficient, degree and describe the end-behavior of the graph.

| Function | Factored Form | Sign of the Leading Coefficient | Degree | End behavior of the graph | |
|---|---|---|---|---|---|
| | | | | Left | Right |
| $P(x) = (x-1)(x^2 - 5x + 6)$ | | | | | |
| $P(x) = (2x^2 - 5x + 3)(x - 3)$ | | | | | |
| $P(x) = x^3 - 6x^2 + 5x + 12$ | | | | | |
| $P(x) = 2x^4 - 3 - 12x^2 + 7x + 6$ | | | | | |

**Assessment 2**

A. Given the function $P(x) = x(x-2)\,(x+1)\,(x-3)^2$ complete the table below.

| Zeros | Multiplicity of Zero | Characteristic of the Multiplicity | Behavior of the Graph |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

B. Given the function $P(x) = x(\,x-2)(\,x+1)(x-3)^2$ compute for the value of $P(x)$that corresponds to each value of x.

| X | $-2$ | $-1$ | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| P(x) | | | | | | |

**Assessment 3**

Indicate the degree and determine the number of turning points.

| Polynomial Function | Degree | Number of Turning Points |
|---|---|---|
| 1. $P(x) = (x-2)(x+1)$ | | |
| 2. $P(x) = x(x+1)^3$ | | |
| 3.$P(x) = x^5 - 6x^4 - 4x^3$ | | |
| 4.$P(x) = x(x-2)(x+1)(x+3)$ | | |
| 5.$P(x) = (x+2)(x-1)(x-3)^2$ | | |

**Assessment 4**

Directions: Sketch the graph of the following polynomial functions. Follow the steps that were discussed from pages 8 and 11. Use a graphing paper for your graphs.

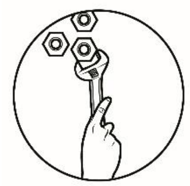
a) $P(x) = x(x-1)^2(x+2)^3(x+3)$
b) $P(x) = 2x^3 + 5x^2 + x - 2$

## *What I Have Learned*

Complete each sentence by filling in the blanks.

Here are the steps in sketching the graph of a polynomial function.

1. Write the polynomial function in ____________ form.
2. Describe the end-behavior of the graph of the given polynomial function using the _______________________.
3. Find the _________ of the polynomial function and their multiplicity.
4. Construct a _________________ for x and $P(x)$.
5. Plot the points and draw a __________ ________________ curve to connect the points.



## *What I Can Do*

Solve.

A box with no lid was created from piece of cardboard 25 cm long and 15 cm wide. Equal squares are cut from each corner of the cardboard and the sides are folder up.

a) Write a polynomial function (in standard form) to represent the volume of the box.
b) Graph the polynomial function.

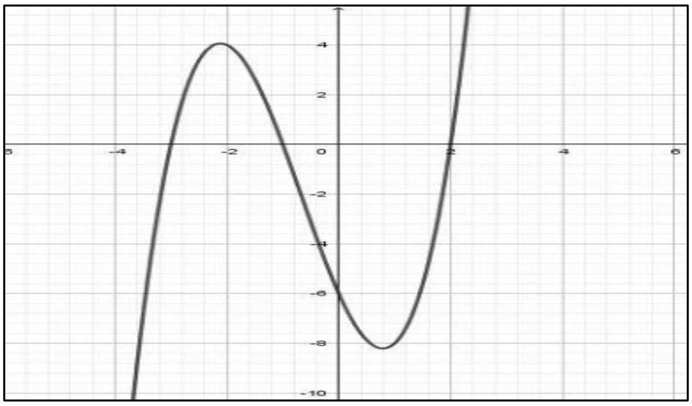
## *Assessment*

Choose the letter of the correct answer and write it on a separate sheet of paper.

1. What are the end-behaviors of the graph $P(x) = -5x + 2x^3 + 3x^5 - 7$?
   A. rises to the left and falls to the right
   B. falls to the left and rises to the right
   C. rises to both directions
   D. falls to both directions

2. If you will draw the graph of $y = x(x+2)^2$, how will you sketch it with respect to the x-axis?
   A. Sketch is crossing both (-2, 0) and (0, 0).
   B. Sketch is crossing (-2, 0) and is tangent at (0, 0).
   C. Sketch is tangent at (-2, 0) and crossing (0, 0).
   D. Sketch is tangent at both (-2, 0) and (0, 0).
3. Determine the number of turning points of $P(x) = (2-x)(x+2)(x+4)$?
   A. 0 B. 1 C. 2 D. 3
4. If $x - 2$ is a factor of $V(x) = x^3 - x^2 - 4x + 4$, what is the other factor?
   A. x + 1 B. x + 2 C. x + 3 D. x + 4
5. Find the zeros of $P(x) = (x-1)^2(x+2)^3$.
   A. $\{1\ multiplicity\ 2, -2\ multiplicity\ 3\}$
   B. $\{-1\ multiplicity\ 2, 2\ multiplicity\ 3\}$
   C. $\{2\ multiplicity\ 1, 3\ multiplicity\ 2\}$
   D. $\{1\ multiplicity\ 3, -2\ multiplicity\ 2\}$
6. Which of the following is one of the factors of $P(x) = x^3 + 2x^2 - 5x - 6$ ?
   A. $x + 1$ B. $x - 1$ C. $x + 5$ D. $x - 5$
7. What are the zeros of the polynomial function $P(x) = (x+5)(x-3)$
   A. $\{-5, -3\}$ B. $\{5, -3\}$ C. $\{-5, 3\}$ D. $\{5, 3\}$
8. Given $P(x) = 3x^3 + 3x^2 - 5x - 24$. What is the value of $P(3)$?
   A. 65 B. 69 C. 67 D. 70
9. How do you describe the end behavior of the graph if the degree is odd and the leading coefficient is negative?
   A. The graph falls to the left and rises to the right.
   B. The graph rises to the left and falls to the right.
   C. The graph falls on both sides.
   D. The graph rises on both sides.
10. Which of the following could be the graph of the polynomial function, $y = x^3 - 4x^2 + 3x - 12$?
   A. The graph falls to the right and rises to the left.
   B. The graph falls to the left and rises to the right.
   C. The graph falls on both sides.
   D. The graph rises on both sides.

11. Which polynomial function in factored form is represented by the given graph?



A. $P(x) = (x - 3)(x - 2)(x - 1)$
B. $P(x) = (x + 3)(x + 2)(x + 1)$
C. $P(x) = (x - 3)(x + 2)(x - 1)$
D. $P(x) = (x + 3)(x - 2)(x + 1)$

12. The graph of a polynomial function rises to the left and falls to the right when its degree is _____________ and its leading coefficient is __________?
A. even, positive
B. even, negative
C. odd, positive
D. odd, negative

13. What are the zeros of $P(x) = (x - 3)(x + 1)(x - 1)$?
A. 3, 1, 1 B. -3, 1, -1 C. 3, -1, 1 D. 2, 1, -1

14. What kind of test uses the leading term of the polynomial function to determine the right-hand and left-hand behaviors of the graph?
A. Number Line Test
B. Constant Term Test
C. Leading Coefficient Test
D. Multiplicity

15. What is the factored form of $f(x) = x^3 + x^2 - 30x$?
A. $f(x) = x(x - 6)(x + 5)$
B. $f(x) = x(x + 6)(x - 5)$
C. $f(x) = x^2(x - 6)(x + 5)$
D. $f(x) = x^2(x + 6)(x - 5)$

## *Additional Activity*

Complete the table and sketch the graph. Use a graphing paper.

| Polynomial Functions | Factored Form | Degree | Sign of the Leading Coefficient | End-Behavior of the Graph | Number of Turning Points |
|---|---|---|---|---|---|
| 1. $P(x) = (x - 2)(x + 1)(x + 3)$ | | | | | |
| 2. $P(x) = -x^3 - 4x^2 + 7x + 10$ | | | | | |

## Answer Key

**What I Know**

1. C
2. A
3. B
4. C
5. D
6. A
7. A
8. B
9. C
10. C
11. B
12. C
13. C
14. A
15. B

**What's In**

| Polynomial Function | | | Non-Polynomial Function |
|---|---|---|---|
| Polynomial Function | Degree | Leading Coefficient | |
| $P(x) = x + x^2 + x^3$ | 3 | 1 | $P(x) = \frac{3}{x}$ |
| $P(x) = x^4 - \frac{1}{8}x$ | 4 | 1 | $f(x) = 9\sqrt{x} + 2x$ |
| $f(x) = x^{\frac{4}{2}}$ | 2 | 1 | $f(x) = 5 - \frac{4}{x^2}$ |
| $P(x) = 4x - 2 + 2x - 3$ | 1 | 6 | $f(x) = x^{\frac{1}{2}} + 2$ |
| $P(x) = 12$ | 0 | 12 | |
| $P(x) = 5x + 1$ | 1 | 5 | |
| $P(x) = x^3 + x^4 + x^6$ | 6 | 1 | |
| $P(x) = 5 - x^{11}$ | 11 | -1 | |

**What's More**

**Assessment 1**

| Factored Form | Sign of the Leading Coefficient | Degree | End-behavior of the graph |
|---|---|---|---|
| $P(x) = (x-1)(x-3)(x-2)$ | Positive | 3- odd | Falls left and Rise right |
| $P(x) = (2x-3)(x-3)(x-3)$ | Positive | 3 – odd | Falls left and Rise right |
| $P(x) = (x+1)(x-3)(x-4)$ | Positive | 3 – odd | Falls left and Rise right |
| $P(x) = (2x+1)(x-1)(x+2)(x-3)$ | Positive | 4 – even | Rise left and Rise right |

**Assessment 2**

| Zeros | Multiplicity of Zero (c) | Characteristic of the Multiplicity | Behavior of the graph |
|---|---|---|---|
| 0 | 1 | Odd | Crosses the x-axis |
| 2 | 1 | Odd | Crosses the x-axis |
| -1 | 1 | Odd | Crosses the x-axis |
| 3 | 2 | Even | Touches the x-axis |

| | | | | | |
|---|---|---|---|---|---|
| -2 | -1 | 0 | 1 | 2 | 3 |
| -200 | 0 | 0 | -8 | 0 | 0 |

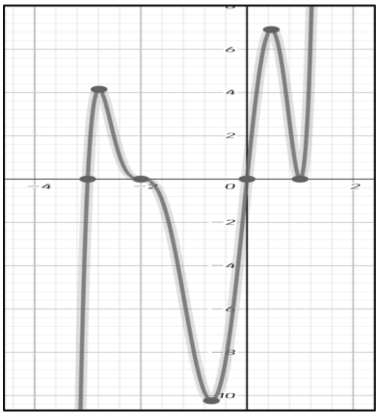
**What's More**

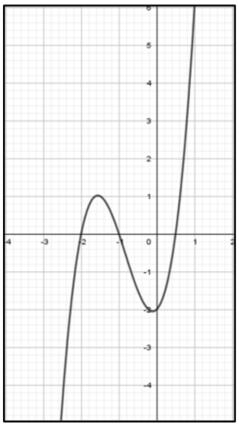
**Assessment 3**

| Degree | Number of Turning Points |
|---|---|
| 2 | 1 |
| 4 | 3 |
| 5 | 4 |
| 4 | 3 |
| 4 | 3 |

**Assessment 4**

1) $P(x) = x(x-1)^2(x+2)^3(x+3)$ 2) $P(x) = 2x^3 + 5x^2 + x - 2$





**What I Have Learned**

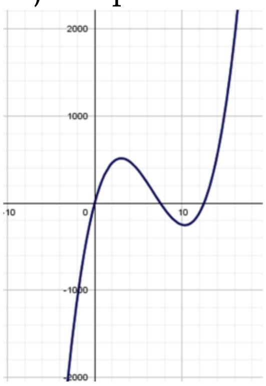
1. factored
2. Leading Coefficient Test
3. zeros
4. table of values

5) 5. smooth continuous

**What I Can Do**

a) $P(x) = 4x^3 - 80x^2 + 375x$

b) Graph



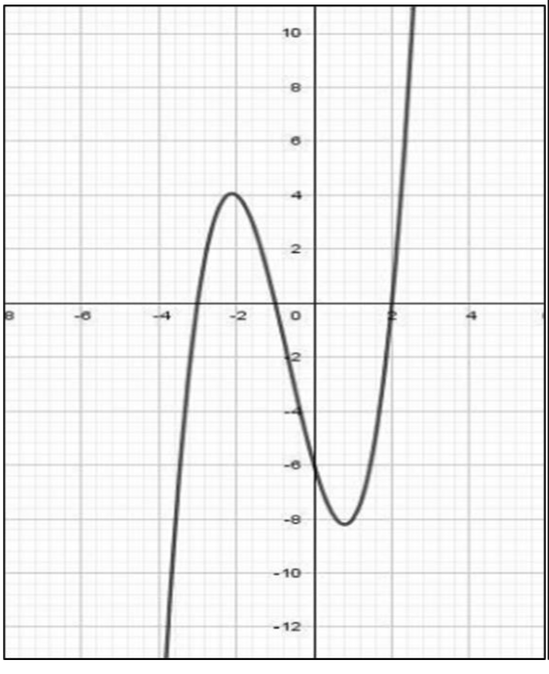
**Assessment**

| | | |
|---|---|---|
| 1. B | 6. A | 11. D |
| 2. C | 7. C | 12. D |
| 3. C | 8. B | 13. C |
| 4. B | 9. B | 14. C |
| 5. A | 10. B | 15. B |

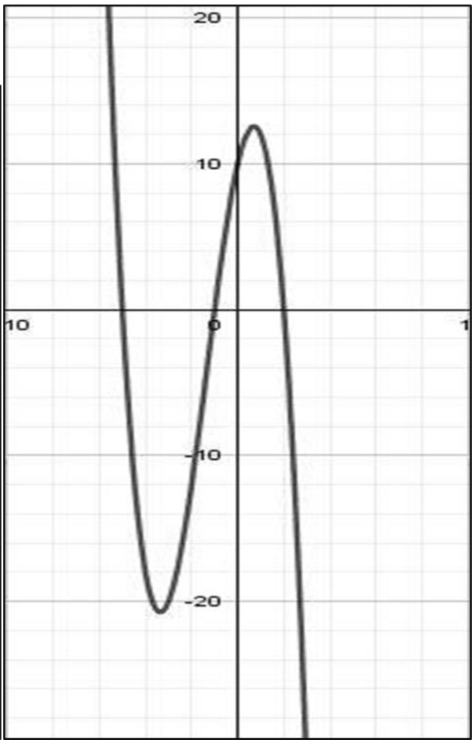
**Additional Activity**

| Polynomial Functions | Degree | Sign of the Leading Coefficient | Behavior of the Graph | Number of Turning Points |
|---|---|---|---|---|
| 1. | 3 | positive | falls left, rises right | 2 |
| 2. | 3 | negative | Rises left, falls right | 2 |

1.




2.



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